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(54) A process controller for concrete mixing

(57) A process controller 1 has a processor 2 with an initialisation controller 2(b), an operations controller 2(a) and a communications processor 2(c). The operations controller 2(a) operates in communication with a machine interface 4 for controlling operations of a concrete-mixing machine 3 for overall job sequencing and individual job control. There is automatic communication by use of polling and return signals to ensure correct sequencing of mixing operations. The initialisation controller 2(b) helps to ensure that the process controller 1 is configured at all times for correct operation at a particular building materials distribution location. The initialisation controller 2b creates a control file 9 and carries out verification operations automatically to ensure that the initially sorted data is correct. The communications processor 2(c) operates with parallel control and transmission files which are automatically transmitted to a host computer for consolidation. Control data in both the control and transmission files ensure data integrity. Delivery records are printed and are stored on disk.

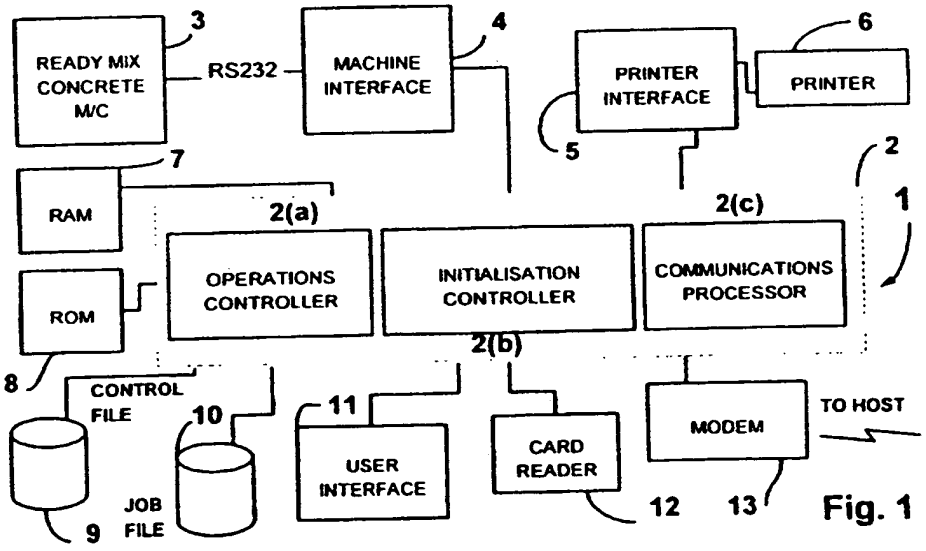

Fig. 1

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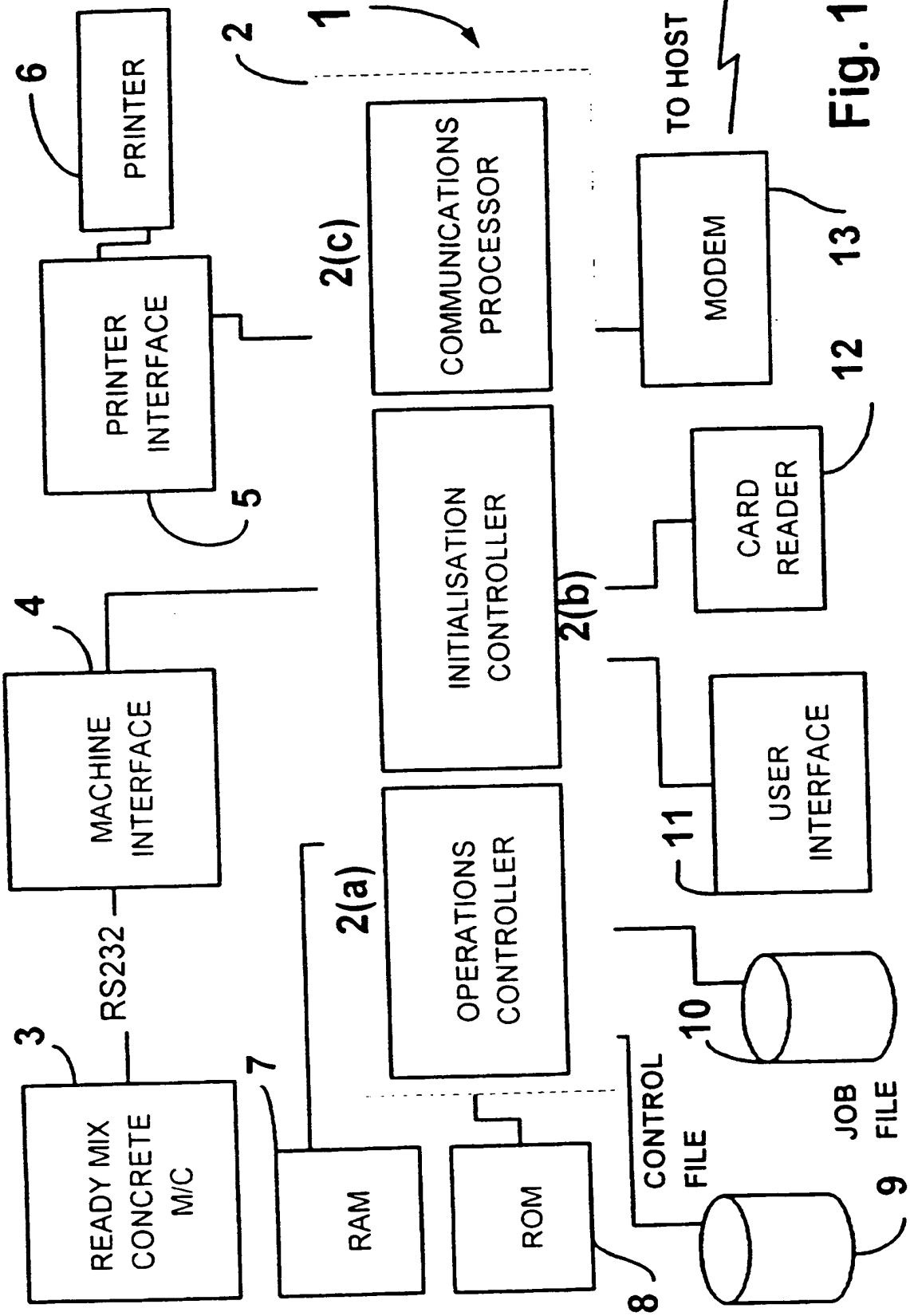

Fig. 1

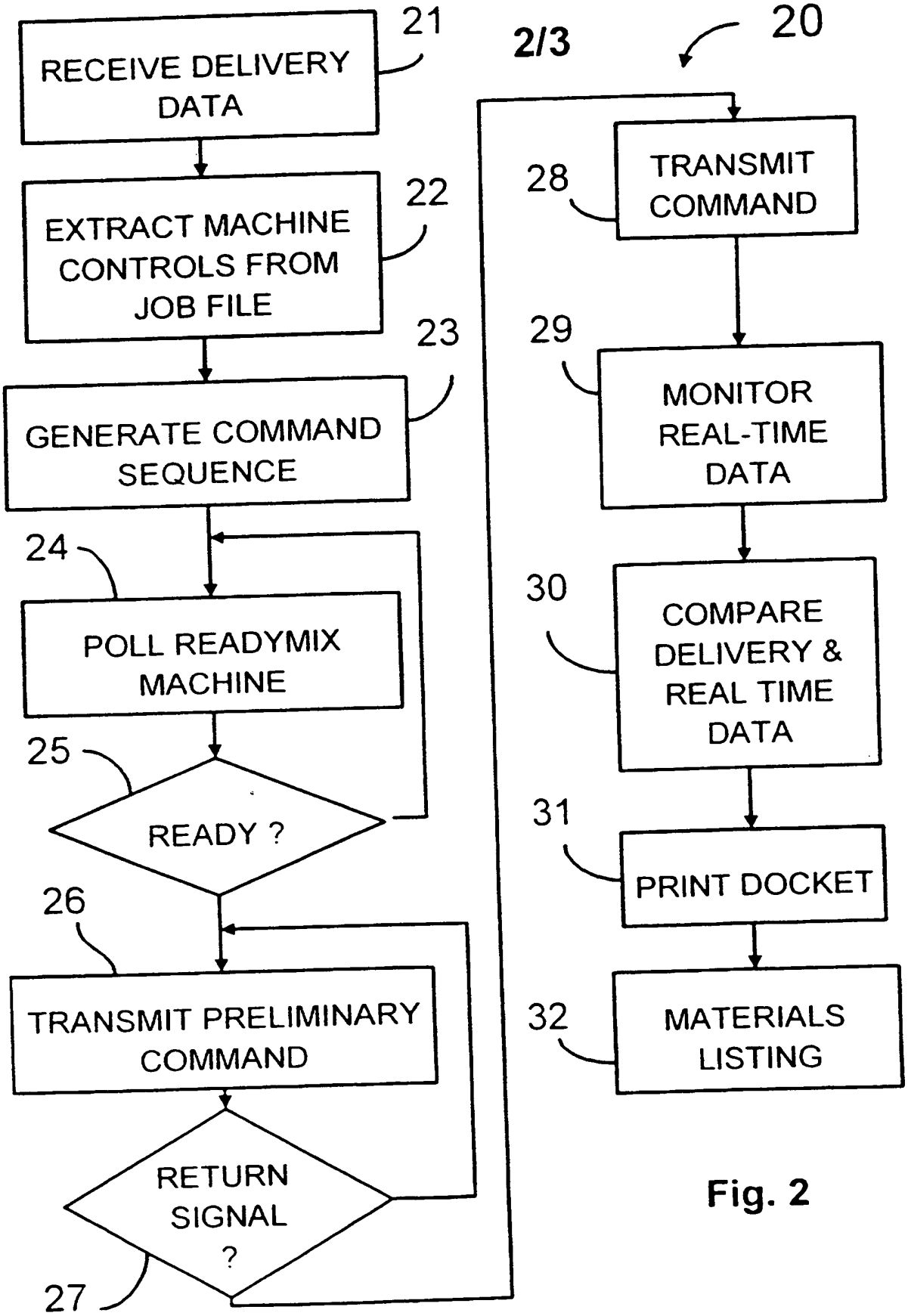

Fig. 2

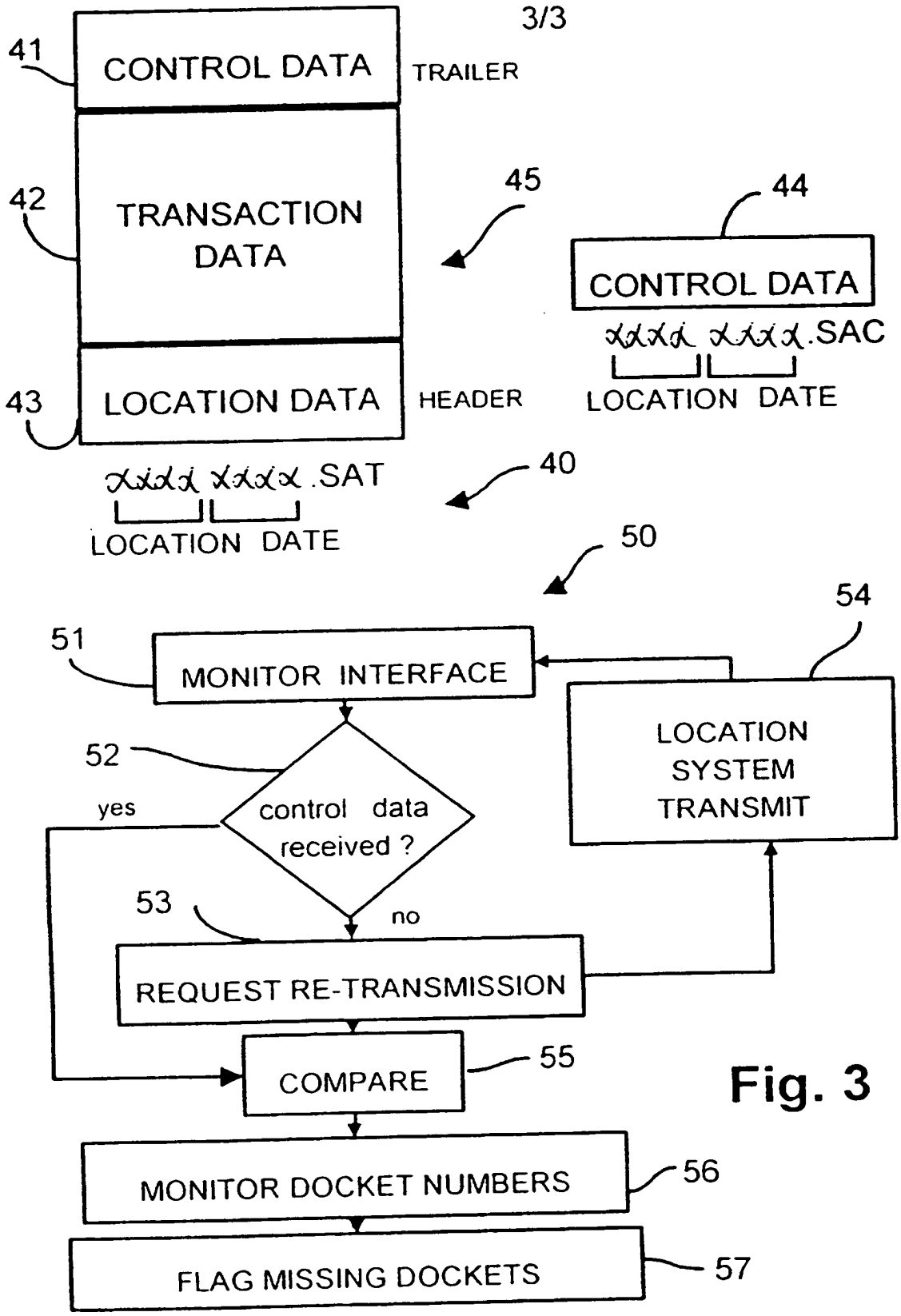
41
CONTROL DATA
TRAILER
42
TRANSACTION DATA
45
44
CONTROL DATA
XXXX XXXX.SAC
LOCATION DATE
43
LOCATION DATA
HEADER
XXXX XXXX .SAT
LOCATION DATE
40
50
54
51
MONITOR INTERFACE
LOCATION SYSTEM TRANSMIT
52
control data received ?
yes
no
53
REQUEST RE-TRANSMISSION
COMPARE
55
MONITOR DOCKET NUMBERS
56
FLAG MISSING DOCKETS
57

Fig. 3

"A Manufacturing Process Controller"

The invention relates to a process controller constructed for controlling manufacturing of readymix concrete.

British Patent Specification No. GB-B-2,144,240 (Ready Mixed Concrete) relates to a method and system for controlling the mixing of concrete in a rotatable mixing drum mounted on a truck. This specification describes various aspects of readymix concrete production with particular emphasis on mixing in the truck. An important aspect is that a further quantity of water is added according to theoretical calculations.

British Patent Specification No. GB-A-2,075,205 (Dorner) describes a system for quantitatively regulating a concrete mixture. A display is generated for actual and desired constituent values of the concrete.

PCT Patent Specification No. WO 91/08882 (Premix A/S) describes a set of modules for use in concrete production for delivery to trucks.

As is clear from a consideration of the prior art, at present, highly automated machinery is available for the production of readymix concrete, however, such equipment is not interfaced directly with a process controller which is constructed for control of transport in an integrated manner.

It is an object of the invention to provide a process controller which interfaces with readymix concrete plant for the timely and efficient delivery of readymix concrete. Another object of the invention is that data which is generated by the process controller be consolidated together in an efficient manner with data

integrity in a host computer system. A still further object is that waste both of time and materials is minimised at a manufacturing location.

According to the invention, there is provided a process controller :

a processor comprising:-

an initialisation controller;

an operations controller; and

a communications processor, and

a readymix concrete machine interface;

a printer interface;

a non-volatile memory device;

a user interface;

wherein the initialisation controller comprises :-

means for dynamically maintaining a control file having values for parameters associated with a manufacturing and distribution location;

means for dynamically storing a table of geographical district codes, each associated with a range of distances between said location and the district;

means for directing storage of a set of truck type codes, each associated with truck data;

means for storing a list of concrete end use codes; and

means for automatically generating a job file for each building site to which concrete is supplied from said location, said job file including automatically retrieved pre-set codes; and

wherein the operations controller comprises :

means for retrieving a job file on receipt of delivery order data at the user interface;

means for automatically generating readymix machine instructions according to data in the relevant job file, and data received from the user interface;

means for automatically generating a command file using the machine instructions;

means for transmitting the command file to the machine interface for transmission to the readymix concrete machine;

means for retrieving operations data from the readymix machine via the machine interface and for retrieving a unique delivery docket number and directing printing via the printer interface of a unique delivery docket for the mixed concrete;

means for writing a delivery record to a non-volatile memory device for each delivery docket printed, said record comprising data captured from print signals transmitted to the printer interface, and

wherein the communications processor comprises means for retrieving the delivery records from the non-volatile memory device and for generating a transmission file which includes control data indicating values of transactions within the delivery records; and

means for automatically transmitting the transmission files to the host processor for consolidation.

Preferably, the initialisation controller comprises means for automatically verifying distance data inputted for a delivery by reference to the reference distance ranges associated with the retrieved district code.

Ideally, the unit comprises means for automatically verifying truck load data by automatic comparison with maximum capacity data stored with reference to the truck type code.

In another embodiment, the operations controller comprises means for initially repeatedly polling the readymix machine for presence of a flag to indicate that the command file may be transmitted, means for transmitting a preliminary command when said flag is detected, means for monitoring the machine interface for receipt of a return signal, and means for transmitting the command file on detection of such a return signal.

In a still further embodiment, the operations controller comprises a means for retrieving concrete mixing data by repeatedly polling the non-volatile memory of the readymix machine for presence of real-time operations data.

Preferably the operations controller comprises a means for inserting an indicator indicating transmission status of each delivery record as it is being written to the non-volatile memory device.

In another embodiment, the communications processor comprises means for automatically generating a header for the transmission file including data relating to the distribution location, and a trailer for the transmission file including the control data.

Preferably the communications processor comprises means for transmitting the control data as a separate file in association with the transmission file for verification by the host computer.

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings, in which :-

Fig. 1 is a block diagram showing construction of a process controller of the invention;

Fig. 2 is a flow chart showing operation of an operations controller within the process controller; and

Fig. 3 is a diagram showing operations of a communications processor within the process controller.

Referring initially to Fig. 1, there is shown a manufacturing process controller of the invention indicated generally by the reference numeral 1. The process controller 1 comprises a core data and command signal processor 2 which is connected indirectly to a readymix concrete machine 3. The concrete machine 3 is of the type for automatic mixing of the various constituents according to electronically stored instructions and for output either to a screen or to a printer of concrete mixing operations data in real-time.

The process controller 1 is constructed for interfacing with the machine 3 and also for interfacing with users and with other devices such as magnetic strip card readers for the control of concrete production at a manufacturing location. Indeed, the process controller 1 may be referred to as a "location system". The controller 1 is also constructed for communication with a host data processor for overall process monitoring and central data processing.

The processor 2 comprises an operations controller 2(a), an initialisation controller 2(b), and a communications processor 2(c). These sections of the processor 2 may take the form of separate microprocessor circuits linked together in a networked arrangement, or alternatively a powerful microprocessor circuit programmed for carrying out operations so that it may be configured at any particular time to operate in any one of the three ways. The processor 2 is connected to the readymix concrete machine 3 via a machine interface 4 which connects with the machine 3 by an RS232 interface. A printer interface 5 is connected to the processor 2 for control of a printer 6. Operations of the printer 6 are very important in material handling, particularly in relation to delivery dockets. Random Access Memory (RAM) and Read Only Memory

(ROM) circuits 7 and 8 are connected to the processor 2. Further, there is a control file 9 and a set of job files 10 connected to the processor 2. The process controller 1 further comprises a keyboard user interface 11, a magnetic card reader 12 and a modem 13 connected to the processor 2. The modem 13 is for communication with the remote host processor.

The manner in which the initialisation controller 2(b) operates is very important to overall operation of the process controller 1. The initialisation controller 2(b) is constructed to initially generate and to automatically maintain the control file 9. The control file 9 is a set of parameter values which control the manner in which the concrete production and output is performed for that particular location. Parameters set by the control file 9 include a weighing method indicator, material loss allowance percentage value and a time period for automatic transmission and deletion of data from the live databases. Indeed, the control file includes values or sets of possible values for important parameters such as the manner of quantifying the constituent aggregate quantity for the readymix concrete quantity as either in tonnes or in cubic metres. An important aspect of operation of the process controller is that it can refer to the control file 9 for a setting of such simple parameter values so that there is consistency in operation of the controller 1 for the particular location.

The initialisation controller 2(b) also directs storage and automatic maintenance of a table of geographical districts in which there are building sites and ranges for distances between the location and each district. It also directs storage of codes for a pre-set group of truck types and end use types. One end use type may be road

construction, whereas another could be housing construction.

The initialisation controller 2(b) monitors the user interface 11 for reception of data relating to a new job which is defined by the controller 2(b) as a new building site which will be supplied from the location. On detection of such data, the controller 2(b) automatically retrieves relevant district, truck and end use codes according to the received data and creates a job file to which these codes are written. Other data received from the user interface 11 is written to the job file and data is subject to automatic verification operations. Such operations include verification of the distance between the site and the location by automatic reference to the ranges associated with the district code. Another operation is verification of the ability of the truck associated with the truck code to carry the load which is requested initially.

Referring to Fig. 2, when data relating to a particular delivery order is inputted in step 21 at the interface 11, the operations controller 2(a) automatically detects this and retrieves the relevant job file. As stated previously, there is a job file for each construction site and in general there could be many different deliveries over a period of time during the construction of the site. The card reader 12 is used for reading a driver code. Interactively received delivery data and data retrieved from the job file in step 22 are used in generating a command sequence in step 23 comprising machine control constructions. This command sequence is in binary format and is stored in the RAM 7. The operations controller 2(a) is constructed to repeatedly poll the readymix machine 3 for a flag to indicate that it can transmit the command sequence. The flag takes the form of a status

register in the machine interface 4. This step is indicated by the step 24 of Fig. 2 and if the flag is present, a preliminary command is transmitted in step 26. The operations controller 2(a) monitors the machine interface 4 for presence of a return signal from the readymix machine 3. A preliminary command is transmitted every three seconds while a return signal is awaited. When the return signal is received, in step 28 the operations controller 2(a) transmits the full command sequence which is received by the readymix machine 3 from the interface 4 and written to a non-volatile memory. The readymix machine 3 has an on-board controller which controls the jobs according to priority data embedded in the commands and it records in the non-volatile memory real-time operations data as concrete is being mixed. The operations controller 2(a) accesses the non-volatile memory (of the machine 3) via the machine interface 4 to monitor it for presence of the real-time operations data as indicated by the step 29.

In step 30, the controller 2(a) automatically compares the delivery data which is embodied in the command sequence and the real-time data which is being generated and in step 31 it prints a delivery docket if the comparison is correct. The docket which is printed has a unique code which is pre-set in the fixed disks of the process controller 1 and verification operations are carried out to ensure that a docket number is not used a second time. There is a set of manual over-ride docket numbers which may be used in the event of breakdown of the processor controller 1. The readymix machine 3 also directs printing of a materials listing in step 32 indicating the materials and quantities used in the mix.

In general, the operations controller 2(a) monitors the sequence of operations of the readymix machine 3 for

overall control purposes. It has been found that by interfacing with the readymix machine 3 in this manner, optimum control is achieved whereby operations of the readymix machine are not interfered with unless absolutely necessary. At the same time, urgent delivery orders may be dealt with efficiently and the quality of the deliveries may be monitored closely.

The operations controller 2(a) is also constructed to handle deliveries of other goods by communication with the user interface 11 which receives data of the quantities and types of goods. The process controller 1 is thus extremely versatile and is used for delivery of different building materials, while being particularly suitable for handling readymix concrete.

An important aspect of operation of the operations controller 2(a) is that it writes a record for each delivery material to disk and sets a flag in the record to indicate whether or not it has been transmitted to the host computer via the modem 13. For various reasons, a delivery record may remain on the process controller 1 without being transmitted for a period of days, depending on the nature of the deliveries involved. However, the control file 9 sets a maximum number of days for holding the data without transmission to the host computer. Upon expiry of this period, the communications processor 2(c) automatically transmits the record. However, in the vast majority of cases, the delivery records are automatically transmitted in an end-of-day process carried out by the communications processor 2(c). The communications processor 2(c) filters the delivery records according to their flags and generates a transmission file storing the records. In addition, the various other transaction data such as purchasing data is automatically written to the transmission file. The communications processor 2(c)

automatically generates a unique name for the transmission file and this is indicated by the numeral 40 in Fig. 3. The name takes the form αααααααα.SAT, where α indicates an alpha-numeric character. The first four characters are a code for the location and the fifth to eight characters indicate the date. The extension "SAT" indicates that it is a transmission file 45. The communications processor 2(c) also automatically creates a header 43 for the transmission file 45, which header includes location data. The various transaction records are written to a transaction data section 42 of the file 40, and finally there is a trailer 41 which includes control data. This control data indicates the number of delivery records included in the file 45, a total quantity for each type of good delivered, a total financial value and data relating to the transactions.

In addition, the communications processor 2(c) automatically generates a control file 44 which is a replica of the trailer 41 of the transmission file 45. However, the control file 44 is automatically assigned a name which has the same prefix as the file 45, but a different extension, "SAC".

The communications processor 2(c) automatically transmits both the control file 44 and the transmission file 45 via the modem 13 to the host computer. The host computer operates according to a method 50 described in the flow chart in Fig. 3 and in step 51 monitors its input interface for reception of these files. In particular, in step 53 the host computer requests re-transmission of both files if the control data (41 and 44) is not received as indicated by the decision step 52. In this case, the process controller 1 automatically re-transmits both files 45 and 44 as indicated by the step 54.

When both the files 40 and 44 are safely received, the host computer in step 55 automatically compares the data in the control file 44 and in the control data trailer 41. If this data is exactly the same, it then automatically processes the transaction data 42 and compares the data values as determined with that in the control data trailer 41. An important aspect of operation of the host computer is that it monitors the docket numbers in step 56 and in step 57 it flags missing docket numbers. There are very strong access control procedures for access to the pre-recorded list to ensure that there is good data integrity and materials control.

It will be appreciated that by the operation of the three sections of the processor 2, comprehensive control of a concrete production and distribution is achieved, while at the same time facilities are provided for consolidation of data at a central location. Interfacing with the readymix machine 3 is extremely reliable and simple to ensure that individual mixes are correct and also that overall sequencing is in order. An important advantage of the invention is the fact that the process controller 1 may be used in many different building material delivery locations by setting of different values on the control file, and without the necessity to modify the sections of the processor 2.

The invention is not limited to the embodiments hereinbefore described, but may be varied in construction and detail.

CLAIMS

1. A process controller comprising :

a processor comprising:-

an initialisation controller;

an operations controller; and

a communications processor, and

a readymix concrete machine interface;

a printer interface;

a non-volatile memory device;

a user interface;

wherein the initialisation controller comprises :-

means for dynamically maintaining a control file having values for parameters associated with a manufacturing and distribution location;

means for dynamically storing a table of geographical district codes, each associated with a range of distances between said location and the district;

means for directing storage of a set of truck type codes, each associated with truck data;

means for storing a list of concrete end use codes; and

means for automatically generating a job file for each building site to which concrete is supplied from said location, said job file including automatically retrieved pre-set codes; and

wherein the operations controller comprises :

means for retrieving a job file on receipt of delivery order data at the user interface;

means for automatically generating readymix machine instructions according to data in the relevant job file, and data received from the user interface;

means for automatically generating a command file using the machine instructions;

means for transmitting the command file to the machine interface for transmission to the readymix concrete machine;

means for retrieving operations data from the readymix machine via the machine interface and for retrieving a unique delivery docket number and directing printing via the printer interface of a unique delivery docket for the mixed concrete;

means for writing a delivery record to a non-volatile memory device for each delivery docket printed, said record comprising data

captured from print signals transmitted to the printer interface, and

wherein the communications processor comprises means for retrieving the delivery records from the non-volatile memory device and for generating a transmission file which includes control data indicating values of transactions within the delivery records; and

means for automatically transmitting the transmission files to the host processor for consolidation.

2. A process controller as claimed in claim 1, wherein the initialisation controller comprises means for automatically verifying distance data inputted for a delivery by reference to the reference distance ranges associated with the retrieved district code.

3. A process controller as claimed in claims 1 or 2, wherein the initialisation controller comprises means for automatically verifying truck load data by automatic comparison with maximum capacity data stored with reference to the truck type code.

4. A process controller as claimed in any preceding claim, wherein the operations controller comprises means for initially repeatedly polling the readymix machine for presence of a flag to indicate that the command file may be transmitted, means for transmitting a preliminary command when said flag is detected, means for monitoring the machine interface for receipt of a return signal, and means for transmitting the command file on detection of such a return signal.

5. A process controller as claimed in any preceding claim, wherein the operations controller comprises a means for retrieving concrete mixing data by repeatedly polling the non-volatile memory of the readymix machine for presence of real-time operations data.

6. A process controller as claimed in any preceding claim, wherein the operations controller comprises a means for inserting an indicator indicating transmission status of each delivery record as it is being written to the non-volatile memory device.

7. A process controller as claimed in any preceding claim, wherein the communications processor comprises means for automatically generating a header for the transmission file including data relating to the distribution location, and a trailer for the transmission file including the control data.

8. A process controller as claimed in claim 7 wherein the communications processor comprises means for transmitting the control data as a separate file in association with the transmission file for verification by the host computer.

9. A process controller substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.